

Low-fat, high-carbohydrate (low-glycaemic index) diet induces weight loss and preserves lean body mass in obese healthy subjects: results of a 24-week study

B. Bahadori,¹ B. Yazdani-Biuki,² P. Kripl,³ H. Brath,⁴ E. Uitz² and T. C. Wascher²

¹Department of Internal Medicine, State Hospital, Muerzzuschlag, Austria

²Department of Internal Medicine, Karl-Franzens University Hospital, Graz, Austria

³Department of Internal Medicine, Division of Oncology, Karl-Franzens University Hospital, Graz, Austria

⁴Department of Internal Medicine, City Hospital Lainz, Vienna, Austria

Background: The traditional treatment for obesity which is based on a reduced caloric diet has only been partially successful. Contributing factors are not only a poor long-term dietary adherence but also a significant loss of lean body mass and subsequent reduction in energy expenditure. Both low-fat, high-carbohydrate diets and diets using low-glycaemic index (GI) foods are capable of inducing modest weight loss without specific caloric restriction. The purpose of this study was to investigate the feasibility and medium-term effect of a low-fat diet with high (low GI) carbohydrates on weight loss, body composition changes and dietary compliance.

Methods: Obese patients were recruited from two obesity outpatient clinics. Subjects were given advice by a dietician, then they attended biweekly for 1-hour group meetings. Bodyweight and body composition were measured at baseline and after 24 weeks.

Results: One hundred and nine (91%) patients completed the study; after 24 weeks the average weight loss was 8.9 kg (98.6 vs. 89.7 kg; $p \leq 0.0001$). There was a significant 15% decrease in fat mass (42.5 vs. 36.4 kg; $p \leq 0.0001$) and a decrease in lean body mass of 5% (56.1 vs. 53.3 kg; $p \leq 0.0001$).

Discussion: In this 6-month study, a low-fat, low-GI diet led to a significant reduction of fat mass; adherence to the diet was very good. Our results suggest that such a diet is feasible and should be evaluated in randomized controlled trials.

Keywords: obesity, body composition, low-fat diet, glycaemic index, weight reduction

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Background

Obesity and obesity-related diseases are one of the major health problems in western countries. In the USA and Europe more than 40% of the population is overweight [1]. The traditional treatment of obesity, which is based on a reduced caloric intake, has only been partially successful, mainly because of a poor long-term dietary

adherence [2]. There are data showing caloric restriction is associated with significant loss of lean body mass, resulting in a decrease in energy expenditure [3] and in fat oxidation [4]. This can be an additional reason for the poor long-term outcomes of low-caloric diets. Reducing fat intake without caloric restriction has been the primary focus of many dietary measures within the last

Correspondence:

Babak Bahadori, MD, LKH Muerzzuschlag, Grazerstrasse 63-65, A-8680 Muerzzuschlag, Austria.

E-mail:

babak.bahadori@lkh-muerzzuschlag.at

20 years. This so-called low-fat, high-carbohydrate diet is capable of inducing weight loss, though the results are modest [5,6]. There is growing evidence of a beneficial effect of diets using low-glycaemic index (GI) carbohydrates in treating obesity [7]. Low-GI foods may favour weight loss by promoting fat oxidation at the expense of carbohydrate oxidation [7]. The low-GI diets may induce greater satiety and, as a consequence, better compliance [8]. Most published data are short-term; there is only one long-term study including 14 subjects [9]. So far, no clinical trial has studied the medium-term effect of a low-fat diet with unrestricted low-GI carbohydrates on weight loss, body composition and compliance in a larger cohort. This study aimed to investigate the long-term effect of this diet in obese, non-diabetic patients.

Methods

Obese subjects ($n = 120$; 66 females and 54 males; mean age 44 years) who wished to lose weight were recruited from two obesity outpatient clinics. Before being enrolled in the study, subjects had to pass a medical examination. This included a medical history, physical examination, measurement of height, weight, blood pressure, an ECG and laboratory profile. The inclusion criteria were ages from 18 to 65, body mass index (BMI) $26\text{--}49\text{ kg/m}^2$ and willingness to lose weight. All patients gave informed consent. Exclusion criteria were the use of any prescription medication, pregnancy or breastfeeding, and any weight-loss diet during the past 3 months. The study was designed and approved according to the local ethics committee guidelines.

Body weight was determined with a Rowenta[®] scale, and height was measured to the nearest 0.5 cm using a stadiometer. Body composition was determined using bioelectrical impedance, a method which involves the measurement of bioelectrical resistive impedance ($R\bullet$) for the estimation of human-body composition. This method is based upon the principle that the electrical conductivity of the fat-free tissue mass is far greater than that of fat. Determination of $R\bullet$ was made using an electrical impedance plethysmograph with a four-electrode arrangement. This method is regarded to be safe and reliable [10]. Multiple frequencies were used to increase the reproducibility of the results [11]. Measurements at 5/50/100/200 kHz were obtained using the Bodystat[®], Model QuadScan 4000[®] BIA instrument, current-source electrodes were placed on the base of the fingers and toes.

Subjects were advised by a dietician on the low-GI diet. They received lists containing glycaemic indices of carbohydrate sources [12] according to the Interna-

tional table of GI and glycaemic load value 2002 (Foster-Powell K *et al.*) [13] and low-GI recipes. They also learned how to measure the GI of mixed meals. Carbohydrate items with a $GI < 45\%$ was recommended, whereas foods with a $GI > 60\%$ was not recommended. This was accomplished by providing each subject with a list of the recommended daily intake of commonly used foods and a substitution list allowing exchanges within food groups. Patients were generally encouraged to take more fruit, vegetables, legumes, whole grain products, pasta and no-added sugar beverages. The patients were also advised to consume as much as 0.8 g of protein per kg body weight per day and to modify their fat consumption. They were advised to use oils containing mono-unsaturated fatty acids such as olive oil, to increase their fish consumption, to eat low-fat cheese, lean meat and to avoid fried foods. The recommended dietary composition was 60% carbohydrate, 20% fat and 20% protein. Patients were asked to complete a food diary during the last 7 days of each dietary period. Foods were separated into full and reduced fat and into low- and high-GI groups. These records were analysed by the same dietician at each time point, with the use of specific criteria, already published by Gilbertson *et al.* [14]. Subjects were categorized from 1 to 3. In category 1, the subject adhered exactly to the advice given; in category 2, the subjects did not completely adhere to the advice given but dietary intake was acceptable; or in category 3, the subjects did not adhere to the advice given and dietary intake was unacceptable. In our study, 72 subjects (60%) were in category 1, 37 subjects (31%) category 2 and 11 subjects (9%) in category 3.

Group meetings were held every 2 weeks for one hour and included dietary and supportive counselling. Weight and body composition were measured at baseline and after 24 weeks. Patients were advised not to do any additional exercise.

The Wilcoxon Signed Rank Test was used for statistical analysis (StatView for Windows; SAS Institute, Copyright © 1992–98; Version 5.0.1). Results are considered significant when p -values are < 0.05 .

Results

One hundred and nine (91%) patients (61 females and 48 males) completed the study; 11 subjects dropped out because they were unable to comply with the diet program. After 24 weeks, the average weight loss was 8.9 kg (98.6 vs. 89.7 kg; $p \leq 0.0001$). There was a significant loss in fat mass (42.5 vs. 36.4 kg; $p \leq 0.0001$) and a decrease in lean body mass of only 5% (56.1 vs. 53.3 kg;

Table 1 Characteristics of patients

Characteristic	Male		Female	
	Week 0	Week 24	Week 0	Week 24
Weight	108.9 ± 24.0	98.8 ± 23.7*	90.4 ± 13.0	82.5 ± 11.4*
BMI	34.2 ± 4.7	31.0 ± 4.8*	32.7 ± 4.0	29.8 ± 3.5*
Fat mass	47.9 ± 11.2	41.1 ± 11.0*	38.2 ± 8.5	32.7 ± 7.1*
Lean body mass	61.1 ± 15.1	57.7 ± 15.3*	52.2 ± 7.5	49.8 ± 7.0*

Data are expressed as mean ± SD.

Weight, Fat mass and lean body mass in kg; BMI, body mass index.

* $p \leq 0.0001$ baseline vs. week 24.

$p \leq 0.0001$). Furthermore, there was a significant decrease in BMI (33.4 vs. 30.3; $p \leq 0.0001$) (table 1).

Discussion

In this 6-month uncontrolled study, a low-fat, low-GI diet led to a significant reduction in body mass and fat mass with a considerable smaller reduction of lean body mass. The paper by Heitmann *et al.* [3] clearly shows that in almost all studies more than 40% of total weight loss is lean body mass, whereas in our patients this was only 31%. We observed good adherence to the diet and a low drop-out rate.

This diet may have benefited patients in our study in two ways: (1) by promoting satiety; and (2) by promoting fat oxidation at the expense of carbohydrate oxidation [7]. These beneficial effects have already been described in the short term elsewhere [8,15]. There is only one long-term study comparing low-GI diet with low-fat diet with 14 patients [9]. Our study is the first medium-term study to combine high-carbohydrate with a low-GI and a low-fat diet. These results suggest a high-carbohydrate low-GI diet should decrease the usual significant loss of lean body mass during weight reduction. There might also be additional benefits from a low-GI diet associated with reduction of hyperinsulinaemia, such as diabetes mellitus [16] and cardiovascular disease [17–19].

In conclusion, our results demonstrate the feasibility and effectiveness of a low-fat, high-carbohydrate with low-GI diet in overweight or obese subjects. We suggest such dietary regimens to be further investigated in randomized controlled studies.

References

- Seidell JC. Obesity, insulin resistance and diabetes – a worldwide epidemic. *Br J Nutr* 2000; **83** (Suppl.): S5–S8.
- Wadden TA. Treatment of obesity by moderate and severe caloric restriction: results of clinical research trails. *Ann Intern Med* 1993; **229**: 688–693.
- Heitmann BL, Garby L. Composition (lean and fat tissue) of weight changes in adult danes. *Am J Clin Nutr* 2002; **75**: 840–847.
- Astrup A, Buemann B, Christensen NJ *et al.* Failure to increase lipidoxidation in formerly obese women. *Am J Physiol* 1994; **266**: E592–E594.
- Astrup A, Grunwald GK, Melanson EL *et al.* The role of low-fat diets in body weight control: a meta-analysis of ad libitum dietary intervention studies. *Int J Obes Relat Metab Disord* 2000; **24**: 1545–1552.
- Astrup A, Ryan L, Grunwald GK *et al.* The role of dietary fat in body fatness: evidence from a preliminary meta-analysis of ad libitum low-fat dietary intervention studies. *Br J Nutr* 2000; **83** (Suppl. 1): S25–S32.
- Brand-Miller JC, Holt SH, Pawlak DB *et al.* Glycemic index and obesity. *Am J Clin Nutr* 2002; **76**: 281S–5S. (Review)
- Ludwig DS. Dietary glycemic index and obesity. *J Nutr* 2000; **130** (2S Suppl.): 280S–283S. (Review)
- Ebbeling CB, Leidig MM, Sinclair KB, Hangen JP, Ludwig DS. A reduced-glycemic load in the treatment of adolescent obesity. *Arch Pediatr Adolesc Med* 2003; **157**: 725–727.
- Lukaski HC, Johnson PE, Bolonchuk WW, Lykken GI. Assessment of fat-free mass using bioelectrical impedance measurements of the human body. *Am J Clin Nutr* 1985; **41**: 810–817.
- Segal KR, Burastero S, Chun A, Coronel P, Pierson RN, Wang J. Estimation of extracellular and total body water by multiple-frequency bioelectrical-impedance measurement. *Am J Clin Nutr* 1991; **54**: 26–29.
- Brand-Miller JC. The Glucose Revolution Life Plan. New York: Marlowe & Company 2001; ISBN: 1569246092.
- Foster-Powell K, Holt SH, Brand-Miller JC. International table of glycemic index and glycemic load values. *Am J Clin Nutr* 2002; **76**: 5–56.
- Gilbertson HR, Thorburn AW, Brand-Miller JC, Chondros P, Werther GA. Effect of low-glycemic-index dietary advice on dietary quality and food choice in children with type 1 diabetes. *Am J Clin Nutr* 2003; **77**: 83–90[1].
- Holt S, Brand J, Soveny C *et al.* Relationship of satiety to postprandial glycaemic, insulin and cholecystokinin responses. *Appetite* 1992; **18**: 129–141.

- 16 Salmeron J, Manson JE, Stampfer MJ. Dietary fiber, glycemic load, and risk of non-insulin-dependent diabetes mellitus in women. *JAMA* 1997; **277**: 472–477.
- 17 Frost G, Leeds AA, Dore CJ *et al.* Glycaemic index as a determinant of serum HDL-cholesterol concentration. *Lancet* 1999; **353**: 1045–1048.
- 18 Jenkins DJ, Wolever TM, Kalmusky J *et al.* Low glycemic index carbohydrate foods in the management of hyperlipidemia. *Am J Clin Nutr* 1985; **42**: 604–617.
- 19 Lamarche B, Tchernof A, Mauriege P *et al.* Fasting insulin and apolipoprotein B levels and low-density lipoprotein particle size as risk factors for ischemic heart disease. *JAMA* 1998; **279**: 1955–1961.